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ABSTRACT

To investigate how writing might be affected by composing aloud and computer composing--two factors that are increasingly being used either to study composing processes or to alter the typical context in which students write--a study described the composing process of five junior high school students. The students wrote four compositons, one in each mode/medium combination: students composed silently or students composed aloud, and students composed using paper and pencil or students composed using a computer with a text processor. The topics given for the writing episodes elicited writing which was reporting (chronological, first-person narrative) in function. Findings indicated that each writing context produced changes in particular aspects of students' composing processes. In a writing context where students composed aloud, more complex patterns of composing occurred than when students composed silently, and in a writing context where students composed using a text processor more revising and more recursive composing processes occurred than when students used pencil and paper. Additionally, students reread their text more frequently and were also more likely to revise after they had reread their text during computer composing. (Eight tables of data are included and 22 references are attached.) (Author/NH)

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HOW COMPOSING ALOUD AND COMPUTER COMPOSING INFLUENCE COMPOSING PROCESSES

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ABSTRACT

Rationale. Writing is a complex activity which is shaped by a number of factors. Previous writing research has shown that some of the factors which influence writing are discourse type, writer proficiency, subject area and audience. Beyond these factors are demands produced by the context in which the writing takes place. This study describes two different contexts--composing aloud and computer composing-- and how these contexts influce writing.

These two factors were examined because they are increasingly being used either to study composing processes or to alter the typical context in which students write. In order to study composing processes, researchers construct "research contexts" in which writers write. In these contexts, writers may be asked to compose aloud (say aloud their thoughts) while writing. Changing the medium with which students write from the usual paper and pencil to a computer with a text processing program also alters the writing context.

To investigate how writing might be affected by composing aloud and computer composing, we described the composing processes of five junior high school students as they wrote four compositions.

Methodology. The study described the influence on writing of two factors: **Mode** (students composing silently or students composing aloud), and **Medium** (students composing using paper and pencil or students composing using a computer with a text processor).

Students wrote four compositions, one in each mode/medium combination. A 2x2 design compared within-subject differences for mode and medium.

The topics given for the writing episodes elicited writing which was reporting (a chronological, first-person narrative) in function. Variables used to examine differences in composing processes included types of revisions and types of composing patterns.

Repeated measure analyses of variance were used to evaluate significant main effects and interactions of mode (silent or aloud) and medium (paper or computer).

Findings and Conclusions. Each writing context produced changes in particular aspects of students' composing processes.

Influence of Composing Aloud: **In a writing context where students composed aloud, we found more complex patterns of composing (a sequence of several thinking aloud and rereading behaviors occuring between actual writing behaviors.) Complex patterns of composing did not occur when students composed silently.**

Influence of Computer Composing: **A writing context where students composed using a text processor promoted more revising and a more recursive composing process. The students did more revising, especially during text production, when they composed using the computer than they did when they used paper and pencil. Additionally, students reread their text more frequently and were also more likely to revise after they had reread their text during computer composing.**

How Composing Aloud and Computer Composing Influence Composing Processes

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1. INTRODUCTION

For the last decade, a major trend in writing research has been the study of the "composing process", or the way writers produce written language. Cumulatively, this research has advanced our knowledge about the processes writers actually use, as well as how composing processes are affected by variables such as discourse type (Emig, 1971; Matsuhashi, 1979), proficiency of the writer (Stallard, 1974; Perl, 1979; Sommers, 1980), subject matter (Marshall, 1984) and audience (Applebee, 1983). We now have good reason to believe that composing processes can be flexible and varied, and are shaped by the variables present in a writing situation.

This study sought to broaden composing process research by investigating the influence of two variables which have increasing been linked with studies of the composing process or with writing instruction: composing aloud and computer composing.

Much of the recent research on composing processes has used a technique termed composing aloud; i.e., writers saying aloud what they are thinking as they write to enhance descriptions. This research has amply shown us the many constraints writers deal with when they write (Berkenkotter, 1983; Flower & Hayes, 1977, 1978; Perl, 1979). However, composing aloud is not a natural context for

writing. Some researchers have voiced concern on the "context-stripping" (Mishler, 1979) of studies where composing aloud is used (Cooper & Holzman, 1983; Faigley & Witte, 1981).

How this research technique affects the normally silent composing process has not been precisely assessed. For researchers building theoretical frameworks of composing, it is important to explore the composing aloud method itself, in order to understand how requiring writers to speak during the process may unconsciously lead to changes in composing processes. The study reported here investigated the influence of mode (composing silently vs. composing aloud) on writing.

Another noticible trend in the last decade has been the growth in availability of microcomputers with text processing programs and an increased use of these capabilities in homes, businesses, and schools.

Computer composing; i.e., initial drafting of writing using a text processor, is likely to influence the composing process. Exploration of this new medium of writing will help us learn about the impact of computers on writing.

As part of a larger study[1] examining composing processes and written products, the study reported here investigated the influence of composing aloud and computer composing on the composing process. By describing in depth the composing processes of five junior high school students, the study investigated how the composing process itself was affected by 1) composing aloud (a research methodology typically used in writing research) and 2) computer composing (writing on a computer with a text processor program.)

[1]Butler-Nalin, K. "Process and Product: How Research Methods and Composing on a Computer Influence Writing" Unpublished Doctoral Dissertation, Stanford School of Education, Stanford, CA. 1985.

2. THEORETICAL FRAMEWORK

Composing Aloud. The composing aloud technique, as it is usually employed (Flower & Hayes, 1978; Perl, 1978; Newell, 1983) relies on writers verbalizing thoughts which co-occur as they write. Writers are instructed to say "whatever you are thinking about," especially when they pause during the composing process. Often times writers are trained to produce protocols which reflect cognitive processes rather than protocols filled with silences or fillers (e.g., "Ummmm...let's see").

Social science research methodologists often term obtrusive measurements, such as composing aloud, in experimental designs as **reactive arrangements** (Stanley & Campbell, 1963). The problem of reactive arrangements is that the artificial context of the experiment and/or the subjects' knowledge of scrutiny by an investigator are often sufficient stimulus for subjects to change behavior. In this study, we looked at composing aloud as a reactive arrangement to better understand what influence this technique may have on composing process research. The concern here is with how the artificial nature of composing aloud might affect the composing process itself, rather than its feasibility and validity as a research tool. Laying aside for the moment theoretical considerations concerning the validity of verbal reflections and the reliable use of the technique, a separate methodological issue raised is the effect on the subjects who are required to verbally reflect on the processes in which they are involved. In a recent article, Swanson et al. (1981) note

> It's a commonplace that if we attempt to focus on how we are doing some kinds of things, we may not only affect the course of the process, but may no longer be able to complete the task....There is also the possibility that calling attention to the need for reports may make subjects self-conscious and lead them to employ different strategies or means than they might if left on their own. (p. 33)

We compared composing processes in two **modes**: composing silently and composing aloud in order to describe similarities and differences in composing processes.

Computer Composing. Much of the literature in the new field of composing and text processors does not address itself to computer composing processes but to interactive instruction systems (CAI) and available software for writing instruction. In their recent article on the writing process and text processors, Bridwell, Nancarrow, and Ross (1984) note, "Research concerning the effects of word processors on writing behavior is almost nonexistent, in spite of a pressing need to explore these effects" (p.383).

The few studies which have looked at computer composing (Bean, 1983; Collier, 1983; Anderson, 1983, Bridwell & Ross, 1984) confirm the initial expectation of increased revising when writers compose using a text processor. However, there has been little exploration of how other composing processes are influenced by computer composing. Here, other processes in addition to revising are described and directly compared to processes occurring when writers compose using pencil and paper. In this way, we hope to broaden descriptions of how text processing might influence composing processes.

3. METHODOLOGY AND PROCEDURES

The study described the influence on writing of two factors: **mode** (students composing silently or students composing aloud), and **medium** (students composing using paper and pencil or students composing using a computer with a text processor). Data was collected from five junior high students participating in text processing classes. Each student wrote four compositions on very similar topics; one in each mode/medium combination.

Composing processes were observed during each writing episode. Following the writing, the composing processes were coded for kinds of revising, where the revising occurred during the writing process, and discrete writing behaviors such as stopping to think or rereading what was already written. A 2x2 design compared within-subject differences for mode and medium. Repeated measures analysis of variance were used to evaluate significant main effects and interactions of mode and medium on the variables.

In the following sections, these general procedures are described in more detail.

3.1 Subjects

Five junior high students participated in the study. All of the students were eighth graders. Of the five students, three were boys and two were girls.

These students were part of a program in place at the school called the "Computer Tutors" program. Students became computer tutors by receiving instruction in how to use microcomputers and in basic programming. They were certified as computer tutors after approximately ten to twenty hours of instruction and practice. After certification, they became eligible to teach other students about using the computers and programming.

The students were selected for their computer experience, not for any particular writing ability. All students were familiar with the computer keyboard; two could touch-type while most looked at the keyboard as they worked. None of the students used only two fingers while working. The students chosen for this study were homogeneous in terms of culture, economic background, previous schooling and general ability.

3.2 Data Collection

This researcher taught classes of instruction for WordStar (a text processing program by MicroPro Software International) to the students in exchange for their participation in the research. The students were taught to use WordStar during ten hours of instruction and practice. As part of the classes, the students were required to write four compositions, one for each mode/medium combination; i.e., composing silently/ paper & pencil, composing silently/computer, composing aloud/paper & pencil, composing aloud/computer.

Compositions using the paper and pencil medium were done as part of WordStar classes, while compositions using the computer medium were done when all WordStar lessons were completed. Since we suspected that composing aloud might affect subsequent composing processes, writing in the composing aloud mode always followed writing in the composing silent mode.

The topics we chose elicited writing whose function was to report. When writing with this function in mind, writers write about past experiences or observations. We assumed that this kind of writing would not only be familiar to junior high school students but would also be a kind of writing with which they were proficient. The topic prompts appear in Table 1. Topics were assigned randomly to mode/medium combination.

The observation of composing processes followed the procedure established by Graves (1974) in his research. As the student prepared to write, a researcher sat next to the student and reproduced what the student wrote using numerals to indicate the writing sequence. Pauses, reading, or talking behaviors were noted by circling the numerals where they occurred in the text and referencing them. For composing aloud episodes, microphones and tape-recorders were set up next to the student; all talking during the episode was recorded.

TABLE 1

Topics for Report Writing

Do you have a pet? (If not, a brother or sister?) Tell me about one special or funny time you had with your pet (or sibling). Be sure to tell me why this was a special or funny time.

Most people have been afraid about something at some time in their lives. Tell me about one time when you were afraid and how you acted. Be sure to tell as much as you can so I will understand why you felt afraid.

Tell me about your favorite vacation. Where did you go? Who did you go with? What did you do that made this time special?

How did you first learn how to ride a bicycle? What was your bicycle like? Who taught you how to ride? Tell me about learning how to ride a bicycle. Be sure to tell me how you felt.

3.3 Instrumentation

In order to describe differences in composing processes of the students, we used two established systems to classify various aspects of the writing. We looked closely at two areas where we expected differences: revising and other patterns of overt writing behaviors.

3.3.1 Revisions

All revisions which the students made were categorized according to a category system used by Bridwell (1979) in her research on revising. This system built upon and extended systems used by other researchers, has mutually exclusive categories and can be coded reliably. The coding system consists of seven hierarchically related syntactic and discourse structures with subclassification of the operations performed on the structure. For better descriptions of revising of a small number of students, we collasped Bridwell's seven categories into three major levels: surface (parts of words and punctuation), lower (words, phrases, clauses), and higher (one or more sentences). [see examples for Revision Coding].

Two doctoral candidates who had used Bridwell's system for another study were raters. Interrater reliability reached .93 for identification and classification of revisions on the students' papers.

Example of Revision Coding: Each revision was coded for level and operation

Level	Operation
1. Surface (parts of words such as spelling, punctuation, capitalization)	1. Addition
2. Lower (changes in words, phrases and clauses)	2. Deletion
3. Higher (changes in single or multi-sentences or at text level)	3. Substitution
	4. Order Shift
	5. Expansion from one level to another
	6. Reduction from one level to another

~~Next~~ Then we went home and told my parents what had ~~happenned~~ happened.
(2.3 lexical substitution) (1.2 spelling)

3.3.2 Patterns during the Composing Process

The most comprehensive system used to categorize and describe overt writing behaviors is the system used by Perl (1978) in her research. This system, derived from listening to audio-tapes of students' composing aloud, has three major areas of behaviors: talking, reading and writing. Each major area has subcategories to further describe composing behaviors.

Because Perl's subcategories were derived from the behaviors of the college students she studied, several modifications within the general category system were made to reflect the students' behaviors in the present study. Perl's system included a number of categories dealing with planning prior to writing; this

primarily involved talking about the topic. Students in this study, perhaps because they were younger or perhaps because the writing task required a chronological narrative of events, did not talk about the topic or how they would proceed prior to writing. Additionally, students in this study sometimes made comments about using the computer (for instance, "Where's the g," when looking for a key). These kinds of comments about the situation were coded in a separate category. Since Bridwell's revising categories were coded, Perl's were omitted. Interrater reliability for coding Perl's modified system was .81.

Next, we described the ways in which series of these overt behaviors were organized into broader composing patterns. Each pattern consisted of two to seven overt behaviors which occurred in a specified sequential order. Constituents of the pattern were three major areas of behavior encompassing all behaviors coded by Perl's coding system: stopping, writing, reading. Stopping included talking, thinking, and pausing behaviors. Writing included all text production and modification behavior (regardless of whether the student was composing silently or aloud). Reading included any silent or aloud reading of text or topic directions.

During text production, each pattern began with a writing behavior followed by alternating read or stop behaviors. The next pattern began when the student began writing again. Following text production, each pattern began with reading behavior followed by stop or write behaviors.

The patterns were then classified according to their complexity. Simple patterns consisted of two behaviors; intermediate patterns consisted of three or four behaviors; complex patterns consisted of five to seven behaviors. Patterns following text production were classified according to whether or not there was any writing behavior in the pattern, since less than 1% of patterns following text production had more than two behaviors. Table 2 summarizes the composing patterns.

TABLE 2

Composing Patterns

During Text Production

1. Simple Patterns of two behaviors
   - 1.1 Write-Stop
   - 1.2 Write-Read

2. Intermediate Patterns of three or four behaviors
   - 2.1 Write-Stop-Read
   - 2.2 Write-Read-Stop
   - 2.3 Write-Stop-Read-Stop
   - 2.4 Write-Read-Stop-Read

3. Complex Patterns of five to seven behaviors
   - 3.1 Write-Read-Stop-Read-Stop
   - 3.2 Write-Stop-Read-Stop-Read-Stop
   - 3.3 Write-Stop-Read-Stop-Read-Stop-Read

Following Text Production

I. Read only
II. Read-Stop
III. Read-Write or Read-Stop-Write

Examples

student composing silently: (writes) The first thing I remember about riding a bicycle is taking the training wheels off of it. (thinks) I remember my grandfather was there at the time, but I'm not so sure about my grandmother. (reads) [code:write-stop; write-read]

student composing aloud: (writes and talks simultaneously) This really frightens the plants and they refuse to grow. (reads silently) (says) "Let's see, what can I say next?" [code:write-read-stop]

4. RESULTS

For this study, the context in which students wrote was changed in systematic ways while the writing task was held constant. Contexts were changed from the more natural context of writers composing alone and silently using paper and pencil, to the writer saying aloud thoughts while writing, and the writer composing using a computer. The next subsections report the results of the analyses of mode and medium on revising and composing patterns. First, statistically significant interactions of mode and medium are reported, followed by significant main effects of mode (composing silently or aloud) and medium (computer composing or composing with paper and pencil.)

4.1 Interactive Effects

Interactive effects show the extent that combinations of mode and medium could not be predicted from corresponding single effects of either mode or medium. We might expect, for instance, that the added constraints on the writer of both computer composing and composing aloud could alter composing processes in ways other than those changed by the effects either composing aloud or of computer composing.

Two statistically significant interactions were found in the proportions of each kind of composing pattern.

Mode (composing silently or aloud) influenced the proportion of intermediate patterns when students composed using the computer. Cell means and a graph of this influence appear in Table 3. Tests of differences for cell means showed when students used the computer and composed aloud, they used more intermediate composing patterns (two or three behaviors between actual writing behaviors) than when they composed silently ($t=2.88$, $df=4$, $p<.05$). There was no difference between modes when students used paper and pencil.

Here we see the possibility that the combination of composing aloud and computer composing may be a qualitatively different writing experience for students. Additional reading or thinking behaviors occurring between actual writing behaviors could be a result of the students' difficulty in simultaneously operating the computer and verbalizing thoughts.

Table 3 also presents the cell means and interaction graph of the proportion of all post-writing patterns. Tests between cell means showed when students composed silently, they had a significantly higher proportion of all post-writing patterns when they used the computer than when they used paper and pencil ($t=3.93$, $df=4$, $p<.01$). This finding supports our expectation that computer composing may

encourage changes both because revisions can be made incorporated into the text neatly, and because the computer may stimulate additional monitoring of the writing.

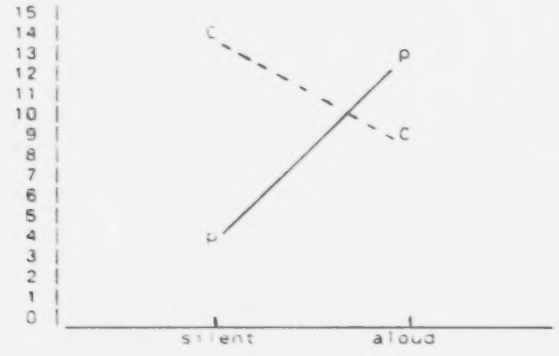
Significant Interactions Between Mode and Medium:
Composing Patterns

Percent All Post-Writing Patterns

Means
(standard deviations)

Paper		Computer	
silent	aloud	silent	aloud
3.8	13.6	14.3	8.9
(8.4)	(19.8)	(6.2)	(12.9)

P--------P paper
C- - - -C computer



4.2 Composing Patterns

This section reports main effects of mode and medium on composing patterns. Composing patterns were based on Perl's (1978) three major areas of overt writing behavior:writing, stopping and reading. Patterns were classified according to their complexity. Simple patterns consisted of two behaviors; intermediate patterns consisted of three or four behaviors; complex patterns consisted of five to seven behaviors. The average proportion of each kind of pattern and the tests of differences are reported in Table 4.

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TABLE 4

Proportions of Each Kind of Composing Pattern

MAIN EFFECTS OF	MODE		MEDIUM	
	Means (standard deviations)		Means (standard deviations)	
	silent	aloud	paper	computer
Kind of Pattern				
Simple	78.2 (12.5)	64.6 (10.8)	73.7 (12.6)	69.1 (11.5)
Write-Stop	48.8 (16.3)	51.4 (15.4)	58.5 (7.8)	41.6 (14.0)
Write-Read	29.5 (22.8)	13.3 (9.0)	15.2 (9.1)	27.5 (10.4)
Intermediate	12.8 (13.3)	19.8 (9.4)	16.1 (15.5)	16.4 (5.4)
Complex	0.0 (0.0)	4.4 (4.7)	1.5 (2.2)	2.9 (4.8)
Patterns after Text Production	9.0 (5.0)	11.3 (15.7)	8.7 (9.1)	11.6 (8.5)

Test of Differences for Proportion of Composing Patterns

MAIN & INTERACTIVE EFFECTS OF	MODE			MEDIUM			MODE/MEDIUM		
	df	F-stat	Sig	df	F-stat	Sig	df	F-stat	Sig
Kind of Pattern									
Simple	1,4	1.19	ns	1,4	0.46	ns	1,4	0.92	ns
Write-Stop	1,4	0.04	ns	1,4	3.24	0.15	1,4	0.26	ns
Write-Read	1,4	1.47	ns	1,4	19.21	0.01	1,4	2.67	0.18
Intermediate	1,4	0.83	ns	1,4	0.0	ns	1,4	11.31	0.03
Complex	1,4	4.42	0.10	1,4	0.25	ns	1,4	0.25	ns
Patterns After Text Production	1,4	0.09	ns	1,4	2.58	0.18	1,4	5.27	0.08

Influence of Mode: Because students must take extra time during natural pauses to say aloud what they were thinking, we expected to find a series of behaviors occurring between writing events. We found the proportion of complex patterns was higher when students composed aloud ($t=2.10$, $df=4$, $p<.05$; one-tailed test). Complex patterns did not occur when students composed silently; regardless of medium. The proportion of all other patterns and the total number of patterns did not differ significantly between modes.

Influce of Medium We found the proportions of composing patterns differed between mediums in the direction of patterns which suggest increased monitoring occurring when students wrote using the computer. Students used an average of 18 patterns when they composed using the computer compared to 10 patterns when they used paper and pencil ($p<.006$). Much of the difference between the two mediums could be attributed to the low average frequency of total patterns when students composed silently using paper and pencil. Cell means for total number of patterns for each mode/medium combination were

- Paper/Silent 7.2
- Paper/Aloud 13.0
- Computer/Silent 18.6
- Computer/Aloud 17.4

Students had a higher proportion of the write-read pattern ($p<.01$) when composing using the computer. Differences between the proportion of intermediate and complex composing patterns were not statistically different between mediums.

We hypothesized that the writing process would be more recursive when students composed on the computer, both because of the ease with which revisions could be made, and because the different context in which the writing occurred would change students' approach to the task. An additional analysis of composing

patterns found that when students used the computer, they reread their own text more often than when they used paper and pencil.

All patterns during text production with the exception of the simple pattern of write-stop included reading as a constituent. The frequency of patterns containing rereading (reading what was already written before producing more text) was 8.4 when students composed using the computer compared to 3.4 when students used paper and pencil ($F=11.36$, $df=1,4$, $p<.03$). Some of the rereading of written text when students compose using the computer is probably triggered by the distance of the terminal display screen from the keyboard, and the varying typing ability of the students. To study whether additional rereading during text production produced differences in composing processes according to medium, we examined how often students revised after rereading their text. We suspected that the frequency of revising following rereading of text would be higher when students used the computer, showing the more frequent rereading of written text was not entirely produced because of physical constraints of using the computer, but rather, because the computer produced additional monitoring behaviors.

Table 5 summarizes the frequency of revising following rereading of the text, for paper and pencil and for computer. The row labeled "yes" shows the frequency that revising occurred following rereading; the row labeled "no" shows the frequency that revising did not follow rereading.

The data in Table 5 show that when students composed using the computer, they made revisions following rereading about half of the time during text production. In contrast, students rarely revised following rereading when they composed using paper and pencil.

TABLE 5

Frequency of Revising Following Rereading During Text Production

	Paper	Computer
Yes	2	40
No	25	38

Chi-square = 16.08; df = 1; p<.0001

4.3 Revising

This section reports main effects of mode and medium on revising. All revisions the students made were categorized into three main levels: surface (parts of words and punctuation), lower (words, phrases, clauses), and higher (one or more sentences). Operations performed on linguistic units (additions, deletions, substitutions, order shifts, expansions and reductions) were also coded.

Length and number of revisions were significantly related (r=.53, df=18, p<.05). To control for length of writing, rate of revisions per 100 words was calculated and compared.

We also categorized the revisions as to where students revised during writing episodes. Revising occurred at three different points: locally (the point of text production), non-locally (elsewhere in the text), and after text production (post-writing).

4.3.1 Levels and Operations of Revising

Table 6 shows the rate per 100 words of revising for the three major levels and each sub-level and reports the tests of differences between these means.

TABLE 6

Revising: Rate per 100 Words for Linguistic Levels

MAIN EFFECTS OF	MODE		MEDIUM	
	Means (standard deviations)		Means (standard deviations)	
	silent	aloud	paper	computer
Surface	5.0 (2.1)	6.2 (2.9)	2.4 (1.1)	8.8 (3.3)
Lower	2.6 (1.4)	2.4 (1.9)	1.4 (1.0)	3.6 (1.3)
Lexical	2.0 (0.9)	1.7 (1.3)	1.2 (1.0)	2.6 (0.9)
Phrase/Clause	0.5 (0.6)	0.8 (0.6)	0.3 (0.3)	1.0 (0.7)
Higher	0.4 (0.4)	0.2 (0.4)	0.4 (0.6)	0.3 (0.2)
Sentence	0.2 (0.2)	0.04 (0.1)	0.0 (0.0)	0.3 (0.2)
Multi-sentence/ Text	0.2 (0.4)	0.2 (0.4)	0.4 (0.6)	0.4 (0.1)
Total rate of revising	8.1 (2.9)	8.9 (5.2)	4.2 (2.4)	12.8 (4.6)
Number of papers	5	5	5	5

Revising: Tests of Differences

MAIN & INTERACTIVE EFFECTS OF	MODE			MEDIUM			MODE/MEDIUM		
	df	F-stat	Sig	df	F-stat	Sig	df	F-stat	Sig
Surface	1,4	1.01	ns	1,4	38.56	0.003	1,4	3.45	0.13
Lower	1,4	0.02	ns	1,4	18.93	0.01	1,4	0.91	ns
Lexical	1,4	0.12	ns	1,4	4.60	0.09	1,4	0.86	ns
Phrase/Clause	1,4	0.47	ns	1,4	6.73	0.06	1,4	0.07	ns
Higher	1,4	2.13	ns	1,4	0.02	ns	1,4	2.89	0.16
Sentence	1,4	3.76	0.12	1,4	9.13	0.09	1,4	3.76	0.12
Multi-sent/ Text	1,4	0.47	ns	1,4	1.79	ns	1,4	0.03	ns
Total Rate of Revising	1,4	0.13	ns	1,4	63.98	0.001	1,4	0.52	ns

Influence of Mode: The overall rates of revising in the two modes (composing silently and composing aloud) were similar. No statistically significant differences were found.

Influence of Medium Because of the ease and neatness with which revisions can be made using text processing, we expected more frequent revising and more revising of larger linguistic units when students wrote using the computer. The rate per 100 words of revising showed significantly higher rates of surface and lower revisions when students composed using the computer. There was a higher rate of surface level revising ($p<.05$). There was also a higher rate of lower level revising ($p<.01$) and a higher rate of lexical revision ($t=2.14$, $df=4$, $p<.05$; one-tailed test), and of phrase and clause revision ($t=2.59$, $df=4$, $p<.05$; one-tailed test). Because there was no single-sentence revising when students wrote using paper and pencil, there was a higher rate of sentence revising when students wrote using the computer ($t=3.02$, $df=4$, $p<.04$; one-tailed test). These findings confirmed our expectations that the computer medium influences the amount of revising students do.

Revisions were coded not only for their hierarchical level, but by the kind of operation performed on the linguistic unit as well. Seven operations were coded: additions, deletions, substitutions, order shifts, expansions from one level to another level, reductions from one level to another, and making a new paragraph (coded for more than one sentence level only). Table 7 reports the average rate per 100 words of each of these operations for lower and higher level revising combined and shows the tests of differences.

Influence of Mode: There were no statistically signficant mode effects for operations.

TABLE 7

Revising Patterns: Operations

MAIN EFFECTS OF	MODE		MEDIUM	
	Means (standard deviations)		Means (standard deviations)	
	silent	aloud	paper	computer
Rate per 100 Words				
Additions	0.4 (0.3)	0.3 (0.3)	0.3 (0.3)	0.4 (0.3)
Deletions	1.2 (0.9)	0.8 (0.8)	0.6 (0.6)	1.3 (0.8)
Substitutions	1.2 (1.0)	1.2 (0.8)	0.6 (0.7)	1.8 (0.5)
Order Shifts	0.1 (0.2)	0.1 (0.2)	0.0 (0.0)	0.2 (0.3)
Expand/Reduce	0.1 (0.2)	0.1 (0.1)	0.0 (0.0)	0.2 (0.2)
New Paragraph	0.1 (0.2)	0.2 (0.3)	0.3 (0.3)	0.04 (0.1)

Test of Differences: Revising Operations

MAIN & INTERACTIVE EFFECTS OF	MODE			MEDIUM			MODE/MEDIUM		
	df	F-stat	Sig	df	F-stat	Sig	df	F-stat	Sig
Rate per 100 Words									
Additions	1,4	0.21	ns	1,4	0.06	ns	1,4	3.64	0.13
Deletions	1,4	0.35	ns	1,4	1.99	ns	1,4	0.46	ns
Substitutions	1,4	0.0	ns	1,4	8.58	0.04	1,4	0.27	ns
Order Shifts	1,4	0.61	ns	1,4	2.47	0.19	1,4	0.61	ns
Expand/Reduce	1,4	0.02	ns	1,4	5.19	0.09	1,4	0.02	ns
New Paragraph	1,4	0.13	ns	1,4	2.35	0.20	1,4	0.33	ns

Influence of Medium: We had expected that more complex operations would occur during computer composing because revising can be done more easily and neatly. Substitutions of one linguistic unit for another occurred at a higher rate when students composed using the computer ($p<.04$). Further analysis of substitutions showed that revisions which were lexical substitutions and phrase/clause substitutions were present in more papers composed using the computer than in papers composed using paper and pencil (see Table 8).

Expansions and reductions of linguistic units from one level to another only occurred when students composed using the computer ($t=2.3$, $df=4$, $p<.05$; one-tailed test).

Order shifts of linguistic units also only occurred when students composed using the computer, although the rate difference between paper and pencil and computer did not reach statistical significance. Chi-square analysis of the presence or absence of order shifts in papers showed that students composing using the computer were more likely to have papers where order shift revising occurred (see Table 8).

4.3.2 Points of Revising

During writing episodes, students revised their texts at three different points: locally (changing the word just written with a surface or lexical level revision), non-locally (revising during text production but not where the student had just written), and after text production (post-writing). In order to see if mode or medium influenced where students revised, we compared rates of revising at these three points. Table 9 presents the rate per 100 words of local, non-local and post-writing revisions and shows the test of differences between these averages.

TABLE 8

Revising Patterns: Use of Specific Operations

Order Shift Revising

Frequency of Papers Containing Order Shift Revising

	Present	Absent
Paper	0	10
Computer	4	6

Fisher's exact test: $p<.04$

Substitution Revising

Frequency of Papers Containing Substitution Revising

Lexical Substitutions

	Present	Absent
Paper	3	7
Computer	8	2

Fisher's exact test: $p<.03$

Phrase/Clause Substitutions

	Present	Absent
Paper	0	10
Computer	5	5

Fisher's exact test: $p<.02$

Influence of Mode: There were no statistically significant mode effects on where students revised during writing episodes.

Influence of Medium: We expected to find more revisions were done during text production when students used the computer because writing would be more recursive when students used this medium. Medium influenced the rate of both local and non-local revising with higher rates of revising done at these points on the computer ($t=6.03$, $df=4$, $p<.01$; one-tailed test for local revising; $t=2.3$, $df=4$, $p<.05$; one-tailed test for non-local revising).

TABLE 9

Revising Patterns: Where Students Revised During Writing Episodes

MAIN EFFECTS OF	MODE		MEDIUM	
	Means (standard deviations)		Means (standard deviations)	
	silent	aloud	paper	computer
Rate per 100 Words				
Local	6.2 (3.1)	7.2 (3.7)	3.6 (1.9)	10.2 (4.2)
Non-local	0.9 (0.9)	0.8 (0.4)	0.3 (0.3)	1.4 (0.9)
Post-writing	0.8 (0.8)	1.0 (1.6)	0.8 (0.9)	1.0 (1.2)

Test of Differences: Where Students Revised During Writing Episodes

MAIN & INTERACTIVE EFFECTS OF	MODE			MEDIUM			MODE/MEDIUM		
	df	F-stat	Sig	df	F-stat	Sig	df	F-stat	Sig
Rate per 100 Words									
Local	1,4	0.85	ns	1,4	36.42	0.004	1,4	0.69	ns
Non-local	1,4	0.16	ns	1,4	5.24	0.08	1,4	0.03	ns
Post-writing	1,4	0.07	ns	1,4	0.23	ns	1,4	1.94	ns

5. DISCUSSION

Within the writing contexts set for them, students in this study wrote easily and showed no difficulties creating their texts. They evidenced familiarity with the form and purpose of report writing by producing personal narrative accounts which varied little with respect to prior planning or basic composing processes.

However, each of the different writing contexts produced changes in particular aspects of students' composing processes. Composing aloud led to more complex composing patterns. Computer composing promoted more revising and a more recursive composing process. The next subsections discuss how these writing contexts influenced different aspects of the composing process.

5.1 Composing Aloud

In order to study composing processes, writing researchers construct "research contexts" in which writers write. From systematic descriptions of their observation of these writers, researchers build theoretical frameworks for composing. However, how the research context itself might affect composing, and thus, affect the theoretical framework produced, is less often scrutinized. This study examined the influence of composing aloud on writing in order to address methodological considerations for researchers studying composing.

We found that composing aloud had little or no effect on revising patterns. It did not influence the rate of revising for linguistic units or operations, nor where during text production students revised. If composing aloud is an additional constraint to writing, it apparently did not change the patterns students use to construct or restructure the language to convey their messages.

We did find evidence that composing aloud changed the tempo of composing processes, resulting in more complex patterns of composing. Between writing behaviors, students displayed more thinking (aloud) and rereading behaviors when they composed aloud. These complex patterns of composing did not occur when students composed silently.

When students composed silently, they proceeded in a rather straightforward way. They wrote, then stopped to reread or think, then started writing again.

When they composed aloud, students wrote and then showed several thinking (aloud) and rereading behaviors before writing again. The examples below show different composing patterns when students composed aloud or composed silently. Each composing pattern is marked by number. Recall that composing patterns during text production always begin when writing commences. Components of composing patterns are writing (silently and speaking aloud the words while writing them), stopping (pauses for thinking silently or for speaking thoughts aloud) and reading (when students' eyes moved across the text or when they read aloud what they had written). In the examples below, WRITING is in upper case: WRITING SILENTLY is in regular typeface, **WRITING AND SPEAKING simultaneously** is in boldface; *reading* is in italics and "speaking" is in quotation marks.

write-stop	1) ONE NIGHT WHILE I WAS WATCHING A TELEVISION PROGRAM SOMETHING HAPPENED THAT WAS TO KEEP ME FROM GOING UPSTAIRS FOR A WEEK. [thinks]
write-stop	2) WHILE WATCHING THIS PROGRAM A VERY SCARY FACE APPEARED ON THE SCREAN SCREEN. AS SOON AS MY BROTHER SAW THE FACE HE LET OUT A LOUD PEIRCING SCREAM. IMMEDIATELY I TURNED THE TELEVISION SET OFF. [thinks]
write-stop	3) WHEN I WENT TO BED THAT NIGHT I DIDN'T WANT TO TURN OFF THE HALL LIGHT. I WAS SO SCARED BY THE FACE THAT I NEVER WATCH THE PROGRAM. [thinks]

--*Takó: composing silently*

write-stop-read	1) **I FIRST LEARNED TO RIDE A BICYCLE WHEN I WAS IN KINDEGARTEN.** "No". *when I was in*
write-read	2) **THE** *when I was in the kindegarten. Kin-de-gar-ten.*
write-stop	3) **THE BICYCLE WHAT** "Whoops!"
write-stop- *read-stop-read*	4) [deletes what] **THAT I USED WAS A BLUE, THREE-SPEED STING RAY.** I "No." [thinks] *I first learned to ride a bicycle when I was in the kindegarten. The bicycle that I used was a blue, three-speed sting ray.* "Ah. Ok. Let's see here. What was my bicycle like? Ok. Huh?" *Who taught you how to ride a bike?* [writing prompt]
write-stop	**MY FATHER WAS THE ONE WHO TAUGHT ME HOW TO RIDE A BICYCLE.** [thinks]

--*Takó: composing aloud*

The three composing patterns in the first example where Take composes silently were all simple ones of write-stop. When Take composes aloud, three of the five patterns are simple: 3 and 5 are write-stop, while 2 is write-read. The first pattern in the second example is an intermediate pattern of write-stop-read, while the fourth pattern is a complex one consisting of five behaviors. Here we see that composing aloud led to more cycles of reading and thinking between writing behaviors. Verbalizing thoughts seemed to draw these students' awareness toward thinking and reading their text, and they exhibited these behaviors in a sequence more often between writing behaviors when they composed aloud.

5.2 Computer Composing

Using a text processing program while writing on a computer allows for legible papers where changes can easily and neatly be incorporated into texts. It eliminates recopying when changes are made and may, because of the computer's need for exact and precise comments and commands, stimulate additional monitoring of the process by the writer.

Although some recent studies have given evidence that computer composing promotes more revision, little or no attention has been given to how computer composing may affect other composing processes. For this study, in addition to revising, we examined points of revising and composing patterns to broaden the emerging portrait of computer composing.

We found that computer composing promoted more revising and a more recursive composing process. The students in this study did more revising, especially during text production, when they composed using the computer than they did when they used paper and pencil. They also used more complex revising operations.

The two examples of composing processes below illustrate differences in revising according to medium. These examples highlight the higher frequency of revision, the different kinds of revision, and the recursiveness of processes during computer composing. In these examples, each sentence is numbered. Local revisions are shown with slashes, while non-local revisions are [*explained in brackets*].

1) My favorite vacation was when I was 10 years old and my family and I went to Las Vegas and the Grand Canyon. 2) We went with a friend friend of my father's who flew us in his airplane. 3) It was a six-seater and I had to sit with the luggage, but I liked it anyway.

4) First we went to Las Vegas for a couple of days and stayed in the Circus Circus Casino Hotel. 5) The part of this I liked most was that I was allowed to play some of the games for children. 6) I won several stuffed animals and gave most of them to my sister.

7) Then we went to the Grand Canyon. 8) I thought it was magnificent, but sort of boring. 9) My parents really enjoyed it and took many pictures.

--*Gwendolyn: paper*

1) For almost two weeks I was thoroughly convinced that I was doomed. 2) Then one night I woke up and looked behind the bed totally sure that there was a monster, just waiting to claw me to death. 3) I slowly looked over the head headboard and realized that there was nothing there. [*changes* looked *in 3) to* peeked].

4) Then I decided that the [*deletes all of 4) then substitutes 3 new words for words in text previous to 1*)].

5) The I Then realized that I had was imagining the entire thing. 6) There was no horrible creature covered festooned with seaweed trying to crush me.
[*inserts* 7) I hardly slept at all and when I did I had gruesome nightmares. *between sentence 1) and 2)*] [*changes* peeked *to* peered *in 3)*] [*changes period to comma in 6)*] it was just my imagination. 8) When I realized this, I could finally get back to sleep.

--*Gwendolyn: computer*

In the first example, only two local spelling revisions are made. The second example shows many surface revisions of spelling and capitalization made on the spot, as well as a large number of word substitutions; some made locally and some made after rereading (as in after the deletion of sentence 4) where Gwendolyn rereads her text prior to where this example begins and makes lexical substitutions there). Another kind of revision characteristic of composing on the computer which occurred rarely when students wrote using paper and pencil, was insertion of new text after rereading (as the insertion of an entire sentence, 7, between two sentences already written).

We also found computer composing was a more recursive process; partly because of the additional revising, but also documented by more composing patterns containing reading text which had been already produced. In the next examples, the differences in composing patterns with reading as a constituent during computer composing are highlighted. Each composing pattern is numbered. Recall that each pattern during text production begins with writing, while patterns following text production begin with reading. In the examples below, WRITING SILENTLY appears as upper case in regular typeface, *reading* is in italics and "speaking" is in quotation marks.

write-stop	1) VACATION [thinks]
write-stop	2) [crosses out vacation] MY ~~VA~~ FAVORITE VACATION WAS ONE I RECENTLY TOOK. I FLEW TO EL PASO, TEXAS, ON A DELTA PLANE. [thinks]
write-stop-read	3) AFTER STAYING THERE FOR~~E~~ A WEEK I FLEW TO ATLANTA, GEORGIA. [thinks] [*reads silently*]
write-stop	4) I WENT TO VISIT MY DAD AND STEPMOM. THIS F~~A~~ VACATION WAS DIFFERENT FROM MOST BECAUSE I HAD NOT BEEN THERE FOR THREE YEARS. [thinks]
write-stop	5) MOST OF THE PEOPLE I KNEW HAD MOVED AWAY, EXCEPT FOR SOME PEOPLE ACROSS THE STREET FROM WHERE MY DAD LIVED. [thinks]
write-stop	6) FOR THREE WEEKS I DID NOTHING BUT SWIM AND READ JUNK MAGAZINES. AS I HAD NOTHING TO DO THIS VACATION WAS BORING BUT FUN. " That's about it."

--Maude: composing silently on paper

write-read	1) I FINALLY LEARNED TO RIDE A BIKE, BUT IT TOOK ME A LONG TIME TO GET USED TO THE IDAE OF HAVING NO~~O~~NE NO-ONE HOLDING ON TO THE BACK OF T~~E~~ THE BIKE. [*reads silently*]
write-read-stop	2) [changes idea to idea in 1)] SINCE THAT TIME I HAVE HAD MANY BIKES RANGING FROM ONE TO TEN SPEEDS. [*reads topic silently, reads text silently*] [thinks]
write-read	3) ONE THING I AM STILL AFRAID TO DO ON A BIKE IS TO GO DOWN A HILL. [*reads silently*]
write-stop	4) [deletes hill in 3) and inserts ONE HILL THAT IS VERY STEEP.] " I guess that's it."
read-write	5) [*reads entire paper silently*] [deletes sentence 3)] ONE THING I AM STILL AFRAID TO DO ON A BIKE IS TO GO DOWN A HILL THAT IS VERY STEEP.
read-stop	6) [*reads silently*] "Ok."

--Maude: composing silently on computer

In the first example of Maude composing using paper and pencil, all but one of the six patterns are simple write-stop. Only one pattern contains reading; the intermediate pattern 3). Notice that when she does reread, she makes no changes. Her revisions are local. In contrast, when Maude composes on the computer, all but one of the patterns during text production contain reading. Following the reading in patterns 1, 3 and 4 she makes non-local revisions. After the fourth pattern, she indicates she is finished writing, then rereads her paper. Following

her rereading, she writes again (although she only makes a single word substitution in the rewriting of the last sentence); reads again; and then stops for good.

These examples show how recursive computer composing can be as Maude actively manipulates the language to convey her ideas. Between writing behaviors she does not only pause to think, but recycles back through the text she has produced; reading and making changes as she does so.

6. IMPLICATIONS

Writing is a complex activity which is shaped by a number of factors. Writers need purposes for their communication, language to express their messages and evaluation skills to monitor the form and content of the message. Beyond these factors are demands produced by the context in which the writing takes place. How composing processes are shaped by two demands from the writing contexts was described by this study. The variables examined were chosen because they are increasingly being used either to study composing processes or to alter the typical writing situations.

By concentrating on the composing process, rather than exclusively on the completed paper, researchers are seeking to build a theoretical framework for composing. This framework better illuminates what processes writers use to create written products, and how they learn to write. Hopefully, process research will lead to a fuller explanation of the role instructional factors have in changing composing processes.

Much of the recent research on writing has used the composing aloud technique to better describe what writers do when they write. This research has amply shown us of the many constraints writers deal with when they write (Berkenkotter, 1983;

Flower & Hayes, 1977, 1978; Perl, 1979). However, composing aloud is not a natural context for writing. The results of this study suggest that for the students examined, composing aloud changed the typical composing silently process. It is important for researchers who are building theoretical models of the composing process to be aware that their research techniques may be influencing the very behaviors they are investigating and for their models reassessed to include this information.

Many questions still remain before we can understand and document the effect of research techniques on writing. How does composing aloud influence the composing processes of other writers? What are the best techniques to use to observe thinking and reading behavior when writers compose silently? Research in this area may be enhanced by restricting the number of different writing contexts and concentrating on direct comparison of composing aloud versus composing silently on a number of papers and with a number of discourse functions.

Much of the focus of computers and writing has been on current computer instructional materials and how they can be used in writing instruction. Much less attention has been turned to the influence of the computer medium alone on the composing process itself. This study showed that computer composing can be systematically different from the composing processes used when writers use paper and pencil.

Without the knowledge of actual computer composing processes, the field of computers and writing is in danger of asking pedagogical questions (e.g., what materials and procedures will improve written composition?) before building an adequate understanding of computer composing processes themselves. When we begin to understand how composing processes and compositions are influenced by the computer medium, we can evaluate our assumptions concerning writing instruction: with or without the aid of computers or present CAI.

Findings indicating changes in composing processes when students use a text processor suggest that composing with a computer could be developed into a pedagogical tool for altering students' approach to writing. However, a number of questions remain to be answered. The relationship between composing processes and written products, and changes which effect both aspects of writing, need to be systematically investigated before we can understand how a change in composing processes might benefit writing.

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